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A full sensitivity analysis of a the analogue downscaling method of precipitation for use in climate change impact studies

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Global climate models (GCMs) are the best tools available to assess the change to atmospheric circulation that an increase in radiatively active gases might lead to. However, it is a well known problem that GCMs cannot fully resolve the local weather variables, especially precipitation, that are important for hydrological impact studies. Downscaling methods are therfore needed to bridge this gap.

The Analogue downscaling (AM) method is a simple statistical downscaling technique using historical observations of weather variables to model future predictions of the same variable. The analogues are typically chosen by comparing features of the large-scale circulation field, such as mean sea level pressure (MSLP) or geopotential heights (GPH). There are many methods for analysing the large-scale circulation, and in this study Tewelus-Wobus Scores (TWS) were selected. TWS compares gradients in the large-scale circulation field and has been used in earlier analogue downscaling studies together with precipitation. Although the AM cannot model precipitation values outside its historical values, it can nevertheless be used in climate change studies. The method can model wet spells over a number of days that succeed observed values, and this might be more important than single day events in terms of flooding. Also, the technique offers possibilities to model ensembles of precipitation time series.

The methodology in this study was to apply a total sensitivity analysis to the analogue method. The parameters varied were (1) choice of large-scale predictor both in terms of single predictors and combinations, (2) method of calculating the distance between grid points, (3) areal extent of the predictor, (4) temporal window of the predictor, (5) number of analogues in an ensemble and (6) weighting of the predictor in terms of directional flow. The predictors included in the study were MSLP, GPH, zonal and meriodonal winds, and specific humidity at different pressure levels.

The methodology was evaluated over ensembles of predictand time series. The results indicate that MSLP together with specific humidity are the best predictors to assess future change in precipitation. The number of analogues in an ensemble prediction should not be less than 30. The conclusion of this study was that AM is promising in terms of applying it to scenario runs with GCM output.